AN INVESTIGATION OF PUBLIC AND PRIVATE R&D PARTNERSHIPS

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ABSTRACT

In this paper we investigate public and private research and development relationships with respect to their performance. The study utilizes a database of over 250 of these relationships, funded by Spanish government agencies. The methodology includes the application of data envelopment analysis (DEA) to determine the relative performance ("efficiency") of the various projects.

THE PUBLIC/PRIVATE INNOVATION ENVIRONMENT

Due to the risk and difficulty of obtaining short-term profitability from new technologies, especially in the initial stages of their development, it is probable that firms do not perceive it as one of the key factors for long term industrial development. In many countries, to help foster corporate innovation, lessening some of the risk for private organizations, governments have been allocating an increasing amount of resources to aid technological innovation in industry, maintaining their country's competitiveness on a global scale. However, simple financial support could be ineffective when the lack of a prior research base or the novelty of technology being developed requires knowledge and resources that are out of reach for an organization. In this case, the interaction between industry and Public Research Centers, (PRCs), (a University and Public Research Organization) could alleviate these deficiencies.

Public research is a resource for accumulating knowledge and expertise which firms can draw upon. Collaboration exposure to PRCs provides a number of benefits to organizations that join with them. Public institutions require some assurance that the financial support will lead to some fruition. A number of issues and characteristics of the innovations and organizations may play a role in how productive they are for generating effective innovations. Identifying these characteristics can help in defining appropriate allocation processes.

In this study, the interaction between industry and PRCs in Spain, in the context of the Concertados Projects (CP) Program, is evaluated. The CP is the instrument of the Plan Nacional de I+D (National Science Research and Technological Development Plan) directed to finance between 40% and 50% of the total cost of these projects through refundable incentives without interest. In order to be eligible for funding, these projects have to be precompetitive research initiatives developed in the framework of a R&D alliance between companies and PRCs. Therefore, the company has to share the execution of the CP's cost with at least one PRC.

Performance evaluation of public and private R&D relationship

Prior literature on performance evaluation in technology and research alliances provide a foundation for measures used in this study. The most traditional approach of public and private R&D relationship performance evaluation is based on quantitative indicators. The advantage of this form of evaluation is that they are "hard" numbers that can be easily manipulated and analyzed. The disadvantage is the lack of intangible factor consideration.

Another issue is the distinction between long-term and short-term performance evaluation (Bonnacorsi & Piccaluga, 1994). Short-term indicators, usually the more concrete, estimate effects of the project on the firm's sales, employment, productivity and so on. The long-term performance of R&D relationships are typically more intangible, making them difficult to quantify. One such example is the "value" of learning produced by actual experience. Geisler & Rubenstein (1989) point out that overall evaluation of benefits and successes can be applied using subjective opinion. This approach contemplates the possibility that university and industry, even different groups of people inside the firm, often have different views effecting what is viewed as a successful project. Maidique & Zirger (1985) define the level of success as the achievement of what was planned, desired or intended. It is assumed that performance depends on how well the intended goals are met, in technical or economic terms. Bonnacorsi & Piccaluga (1994) consider this notion very restrictive and not applicable to high uncertainty situations such as the creation of scientific and technological knowledge. In this situation, the "official" objectives are so unspecified that it is impossible to contrast their performance level. It is not a matter of assessing the adequacy of means to given goals, but of generating simultaneously, means and goals, indicating that the evaluation of performance of the R&D relationship may change from a purely instrumental role to a goal-generating role. Thus, evaluating CP using varying measures and dimensions is recommended and appropriate. The DEA methodology helps bring together a number of performance dimensions, providing relative efficiency measures of these projects.

Performance Conditions for Public and Private R&D Partnership

In order to evaluate the performance of the public and private R&D relationship, it is not enough to know the performance of the R&D relationship. It is necessary to understand and assess the factors that influence the performance of the R&D linkage. We study three groupings of characteristics that may influence performance of the R&D relationship: (1) characteristics of the firm, (2) nature of the R&D project, and (3) nature of the linkage.

Characteristics of the firm that collaborate with the PRC

Companies participating in CP's activities vary on a number of factors. These characteristics may be important in discriminating between good and poor CP performers and determine the type of public support. To analyze this relationship between performance and firms' characteristics three variables were evaluated: (1) the size of the organization, (2) the existing knowledge base and (3) the competitive strategy. These variables are linked to Cohen & Levinthal's (1990) notion of learning capacity, which is related to the effectiveness at acquiring knowledge and know-how. The size of an organization may provide insight into the learning model developed by a firm. Evaluating the existing knowledge base determines how the firm's base of knowledge prior to the alliance influences the effective acquisition and utilization of new knowledge. Competitive strategy aimed to build and enrich their scientific knowledge base helps the firm in the market. This point suggests that the competitive problem relates to the performance of PC.

The Nature of the R&D Project.

R&D projects developed in the realm of the CP alliance present a broad range of characteristics that influence the performance of R&D linkage. To study this relationship, characteristics such us the technology to be developed, independence of innovation, type of innovation, state of knowledge development and universality of knowledge were analyzed.

Cross-technology differences influence the strength and character of R&D linkage activity, especially in the knowledge contribution of the PRC to the firm. Innovation dependency, relates to the amount of internal functional dependency that exists, determines the feedback between technologies user, supplier, and producer and the project organizational complexity. The diversity of outcomes that display the CP in terms of complexity, ambiguity and abstraction also govern the performance of the CP. Likewise, studies show that the importance of PRC inputs is especially intense at the beginning of the development of the knowledge field and that decline when the technology has become more established and companies begin to build up in-house research capability. Finally, advancements in generic knowledge may eventually result in dramatic productivity increases and cost reduction in the design of activity (e.g. algorithms for parallel computing, new design tools, simulation techniques and so on), but may be less appropriate than local knowledge for the organization.

The Nature of the Linkage

The nature of the linkage focuses on the relationship characteristics of the CP. The characteristics used to analyze this relationship include: resources involved; prior experience in R&D collaboration; benefits sought; relationship propinquity; and what motivated the organization to enter into the CP.

The first resource consideration examined is the total budget assigned to the R&D activity associated with the CP. It can be argued that larger budgets are associated with more complex types of relations. When a new private-public partnership is created, the partners may have initial uncertainties about working together. However, if they have prior collaboration experience, they may have more trust, less time to “get used to each other”, and other factors which provide an impetus for a more productive relationship. Economic analysis of technological innovation would argue that the benefits and motivation leading private profit-oriented firms to enter into an R&D relation with a PRC may impact the eventual level of performance for the CP. Another important issue to be taken into account is the capability of the partnership to create an environment that fosters knowledge-sharing. We also consider the internal group that originates and supports the CP project. They often play the role of internal entrepreneur. This factor is very important because the efficiency of the linkage depends on the ability of this group to overcome the political, technical or economic barriers and resistance that the alliance encounters.

RESEARCH DESIGN

The analysis of these public and private R&D linkages is based on two data sources. The first is the Centro de Desarrollo Tecnológico Industrial’s (Centre of Industrial Technological Development, CDTI) administrative database. The information supplied is related to Spanish firms that participate in the CPs with at least one PRC. After the analysis of the information provided by CDTI about the companies that execute the CPs, another questionnaire was designed to gather additional qualitative and perceptual information. The questionnaire was used to acquire information related to the three blocks of factors defined in the previous section. The form was distributed among 317 firms that had applied for 496 CPs during the periods1988 until 1993. 118 companies responded to the questionnaire, which resulted in information on a total of 281 projects, 56.65% of the project sample. After eliminating CPs with missing data a total of 278 projects were used in the final analysis.

Methodology

DEA is used to determine the relative performance, “efficiency” of each of the CP. DEA productivity models for a given “decision making unit” use ratios based on the amount of outputs per given set of inputs. In this paper a decision making unit is a CP.

The DEA based performance model that is used in evaluating the performance of the partnerships is the one proposed by Rousseau and Semple (1995), which focuses on preservation of a unit’s classification. This approach is based on determining a unit’s sensitivity to changes in the data values. The formulation used here to evaluate the CPs data set is the generalized Techebycheff radius of classification preservation (GTR) model.

The Performance Evaluation Model

The DEA performance evaluation model uses three input measures and three output measures. The inputs are the turnover of the company (total revenue), number of employees in the company, and total R&D budget. Three values were used as outputs, total number of patents from that project, the second is total employment generated by the CP, and the final output is total income generated by the CP. The total number of patents included both national and international patents. The total employment generated included laboratory employees, research and development employees, and total number of general employees. The impact on the Spanish economy, export technology produced by the CP that brought in revenues, and the technology transfer impacts of the new technology were all included. The data was then mean normalized, so that scale effects on the software package (the DEA programs were run on Lindo subroutines) would be minimized. Once the scores were calculated, a number of non-parametric statistical tests to explore various characteristics were completed.

MAJOR FINDINGS

Firm Determinants. We observe that the firm's size influences performance. Larger organizations performed better than smaller organizations. This result shows the difficulties small organizations (SMEs) have in accessing PRC's expertise and resources. Their lack of financial support and limited resources seems to have impaired their capacity to develop new knowledge and implement the results of the R&D alliance. Given the relevance that the SMEs have in the Spanish productive sector, it is necessary to design instruments that permit the modernization of these companies. If not, it will impede small organizations in creating and developing a technological foundation.

It is also apparent that efficiency of the linkage is influenced by strategic issues. Cost reduction, as an emphasis of an organization's strategy bodes well for performance of these types of projects. In contrast, CPs whose organizations had new product development as their strategy do poorly. A possible explanation for this result could be found in the fact that firms strategically more active in terms of research, assume more risk, develop the most complex projects and face more difficulties in the implementation of the results.

R&D project Determinants. Our evidence emphasizes the general importance of the nature of technology target project on performance. Apparently, technologies considered more mature as Agriculture & Food, Forest and Environment, performed better than technologies associated to more dynamic fields as Biotechnology and Automation and Robotics.

Not all the expected technical outputs performed equally. These findings confirm that those organizations that had a very concrete and defined output as a prototype or pilot plant performed better than a partnership associated with less concrete objectives. When the R&D project depends on other R&D projects or other functions, performance is not as good. To avoid some of the problems of complexity and dependence, innovation should be integrated, especially with the production and commercialization process (Ingham & Mothe, 1998).

Linkage Determinants. Successful R&D public/private partnerships require a minimum (threshold) budget that allows them to respond to the dynamism and change associated with R&D projects. In order to be more efficient, our research suggests the need to concentrate on the development process of the R&D alliance. The lack of significance for building relationships go against some of the research, especially when building relationships is based on trust. The notion that trust is critical in R&D partnerships has been discussed in the literature (Hamel, 1991; Dogson, 1993). The issue of trust building (close relationships) may be more critical between industrial partnerships than public-private relationships, and needs to be further studied.

SUMMARY

The complex and interrelated nature of the factors here impair any simple explanation of the public and private R&D partnership's performance. However, some clarification and significant discrimination between good and poor performance appeared on a number of factors. These major factors should be further investigated by policy makers to determine what is feasible and controllable in identifying CPs for financing and support. In addition, generalizations to other countries and PRC types cannot necessarily be made without further investigation.

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